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ABSTRACT

As one phase of a research program on teacher effectiveness, five studies were completed which sought procedures for aiding teachers in the acquisition and expression of hypothetico-deductive verbal structuring through microteaching. Hypothetico-deductive verbal behaviors have been found to be related to desirable pupil outcomes. The evidence collected in these studies suggests that hypothetico-deductive structuring can be measured using multi-dimensional observation instruments; is enhanced by reinforcement of models of the behavior; is not dependent on subject content areas, and can be used by any teacher; and results in more student talk. The research completed thus far will enable the investigators to design empirical studies which test the relative efficacy of alternative training methods and the influence of manipulating teacher utilization of hypothetico-deductive structuring moves on student outcome measures. (Author/HMD)

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MICROTEACHING FOR THE ACQUISITION OF HYPOTHETICO-DEDUCTIVE STRUCTURING VERBAL BEHAVIORS: A PROGRAM OF RESEARCH

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INTRODUCTION

The systematic analysis of classroom interactions has been a major element in the search for a theory of teaching. With regard to studies that have stressed the systematic analysis of classroom interactions, reported research may be classified into three types: (1) attempts to describe elements of the interactions present in various instructional settings; (2) attempts to correlate or experimentally test the effects of certain linguistic paradigms or language configurations on selected student outcomes; or (3) attempts to modify teacher verbal behavior to include particular verbal strategems through varying feedback and reinforcement schedules. A review of the literature in this research domain indicates a preponderance of type 1 and type 3 investigations. There is adequate justification for research efforts of both types, but their efficacy must be questioned if claims and counter claims about the progress toward a theory of teaching are made upon the basis of investigations of these two types only. In research studies of the first type, the investigator will rarely make claims as to the effectiveness of the occurrence or non-occurrence of the behaviors under perusal -- although their relative values are implicit by virtue of the fact that they are indeed being described. Type three studies are, for the most part, conducted without knowledge as to the effects

that utilization of specified behaviors by teachers have on student outcomes. There may be a host of reasons for this, but the great frequency of investigations of this type is astounding.

The following is a description of one phase in a program of research on teacher effectiveness being conducted at the University of Florida. The individual phases of this program of research will encompass investigations of all three types listed above. Of central concern to this program of research is the effect of teacher utilization of logical paradigms associated with the verbal instructional strategy termed "hypothetico-deductive structuring."

RATIONALE

There have been studies to date which indicate that the utilization of the language of formal logic in verbally mediated instruction is correlated with student achievement, student growth in logical reasoning ability, student recall of relevant information and teacher questioning strategies. Of particular significance for this project, Gregory (1972) reported that a positive correlation existed between seventh grade student growth in conditional reasoning ability and student membership in a mathematics class in which the teacher used a high frequency of conditional moves. In this report, concern was

expressed as to whether or not techniques for assisting teachers in the acquisition and utilization of the conditional move could be found. If the conditional move was to be tested experimentally, it became necessary to find means by which the frequency with which teachers use conditional moves may be manipulated. If the relationships of the conditional move to other classroom interactions were to be identified and described, it became necessary to find an instrument that describes with some precision the behavior of teachers and students participating in instructional activities. To date, research at the University of Florida has stressed establishing these two conditions -- the capabilities of manipulating conditional moves and of describing its ecological influence as one element in the verbal environment of instruction.

THE PROBLEM

The program of studies reported here sought answers to the following questions:

1. Can feedback on teaching, mediated by a multidimensional observation instrument assist teachers in the acquisition of these behaviors?

2. Does withholding specific aspects of the feedback process and extending the mediation to include video-tape models of the desired behaviors affect skill acquisition?
3. What changes in verbal strategies used by teachers can be attributed to both the feedback variation and the acquisition of the verbal structuring skill?
4. What changes in the total verbal environment, with particular concern for the verbal production of students, can be attributed to the modification of the teacher's verbal behaviors?

INITIAL STUDY

The first step was to find a multi-dimensional observation system which met three criteria:

1. theoretical construct validity in terms of expected and desirable student and teacher interactions;
2. conceptual validity in that student and teacher behaviors could be coded reliably by those trained to use the system;
3. empirical validity in that patterns of behavior recorded by the observation system might be used as a basis for predicting the frequency of teacher utilization of conditional moves.

To this end, twenty randomly selected transcripts of seventh grade mathematics teachers obtained in the Gregory (1972) study were coded using the Social Science Observation Record (Casteel, Gregory, and Koran, 1974). A step-wise regression analysis between cell frequencies and conditional move frequencies led to measures from the SSOR which accounted for 89% of the variance in conditional move frequencies. The variables associated with the use of conditional moves were teacher use of lecture (category 7) and a combination of lecture followed by questions (category 7 followed by category 9).

A re-analysis of the transcripts and audio recordings of mathematics, social studies and science lessons yielded a description of the occurrence of this logical paradigm. In the lecture mode, the conditional move is "hypothetico." That is, it introduces a hypothetical variant which establishes a structure or defines a context within which concepts, principles and procedures are to be discussed. Thus it has the function of cueing. The words generally associated with this conditional move are "assume" and "suppose."

In the inquiry mode, the conditional move is "deductive." It serves to "link" the basis provided by the hypothetical structure to a question or statement of conclusion or consequence. This linking function is generally delivered in the classical "if-then" form.

Although these two modes can function independently, pedagogical quality is enhanced when the two moves are used jointly in what is termed "hypothetico-deductive structuring." Since the establishment of one hypothetico structure usually leads to several deductive moves on the part of the teacher, coding individual factors of the hypothetico-deductive structuring moves separately has not, so far, been warranted.

In terms of the SSOR coding system, the hypothetico-deductive structuring move takes the form '7✓7 7 7✓9 16" where a "7" refers to a three-second segment of teacher statements, "9" refers to a teacher question (three seconds or less), "16" is three seconds of silence, and the "✓" indicates utilization of the conditional move. An example of this move follows.

Example

> Suppose you are on an airplane traveling over the Atlantic. And let's assume that the oxygen masks drop out of the ceiling. If there is no stewardess in sight, what would you do?

MODIFICATION STUDIES

The studies to be reported were conducted in order to aid in the development of a training program designed to increase the utilization of this instructional strategy by pre-

service and inservice teachers. The studies intended to answer questions relative to teacher acquisition and increased utilization of factors of the hypothetico-deductive structuring move were not primarily intended to empirically test the technique used. However, a brief description of the technique used in each study is warranted prior to the presentation of findings.

Technique I

Ten middle school student teachers (5 math, 5 social studies) attended a four-hour presentation of the SSOR. The presentation consisted of a discussion of the categories, methods used in coding, the SSOR matrix display and its interpretation, and the procedures and topic for the two microteaching lessons they would teach. All subjects individually taught a fifteen minute lesson in their content field based on a newspaper article dealing with the inequity of women's salaries in relation to men's salaries. Each subject brought five of their own students to a microteaching center set up in the school's guidance office. Each subject received individual feedback from the two investigators according to one of three treatments to which they were randomly assigned within subject matter area. Two subjects viewed a video-tape recording of their own lesson and followed the SSOR codings which were made during the live lesson presentation. Reinforcement consisted of statements indicating that they had done a fine job, that they looked poised and that they would find microteaching the same lesson to a different group of students easier during their next session a week later. (Treatment A.)

Four subjects in addition to receiving Treatment A, were asiisted in interpreting the SSOR matrix display in relation to thier objectives for the lesson. (Treatment B.) The remaining four subjects received Treatment B and were reinforced on the use of sevens followed by nines (teacher statements followed by teacher questions) and on the elimination of nines followed by sevens. (Treatment C.)

All subjects then taught a second lesson on the same topic to five different students.

Technique II: Model Viewing

Four student teachers of high school mathematics attended a four-hour presentation of the SSOR which was comprised of the elements discussed under Technique I. Each subject taught a 15-minute lesson in a microteaching laboratory set up in the school media center to five ninth grade students provided by the investigators. The topic for all lessons was "permutations." Each subject received individual feedback from the two investigators according to one of two treatments to which they were randomly assigned. Two subjects received the feedback described as Treatment C under Technique I, plus reinforcement of the structuring move (Treatment D).

The treatment for the other two subjects differed in that the feedback session was extended to include the viewing of a video-taped lesson in which a mathematics student teacher used a high frequency of hypothetico-deductive structuring moves. (Treatment E.)

All subjects then taught another lesson on the same topic to five different students during the following week.

Replication of this technique was performed during the following quarter. The subjects were students enrolled in a microteaching course prior to student teaching. They were randomly assigned to provide four subjects in Treatment D and four subjects in Treatment E.

Technique III: Training and Microsimulation

Twelve students enrolled in a microteaching course during the quarter prior to student teaching (four math and eight English) received eight hours of instruction in coding classroom verbal behaviors utilizing the SSOR. Each subject achieved criterion levels for coding a three-page transcript of classroom verbal behavior, identifying categories, realms and submatrices of the SSOR system, and identifying SSOR cell utilization from hypothetical descriptions of teacher questioning strategies. This instruction also included training in the use of hypothetico-deductive structuring by participation

in simulation games, model viewing, and structuring move identification. Each student then taught a 12-minute lesson on a topic of his choosing to five other students from the class in a microsimulation session. Each of the six subjects in the session presented their lesson to the other five subjects in that session. Each subject then received individual feedback using Treatment D. During the week following individual feedback sessions each subject presented a different lesson to the same five subjects in attendance during the first session. This second session differed from the first in that all students viewed the video-tape recording of the first lesson taught in this session with the investigator stopping the tape for each question and reinforcing the utilization of a hypothetico-deductive structuring move. The same feedback was provided after the second lesson of this session, after the third lesson, and so on.

Technique IV: Training, Microsimulation and Microteaching

Ten preservice social studies teachers enrolled in a microteaching course during the quarter prior to student teaching received similar treatment to that received by subjects in Technique III. The procedures differed only in the number of microsimulation sessions in which each subject participated and with the addition of a microteaching session in which junior high and high school students participated. One lesson was presented in each of four microsimulation sessions and one microteaching session.

For all techniques the variables of interest were measured through the application of the Social Science Observation Record by two trained coders. Reliability coefficients computed in each study were consistently .72 or higher.

RESULTS

The prodedures utilized were intended to provide data which would aid in the evaluation of elements of a training program for preservice teachers. The comparisons between groups in the five studies are important only in relation to the increased utilization of the desired behaviors. That is, consistency and degree of improvement was deemed to be a more valid technique of evaluation then statistical comparisons of the various techniques used. A major part of this decision was based upon the fact that uncontrollable differences exist between the groups used in each technique. Variables such as history, degree of professional education, and methods course instructors were beyond the control of the investigators.

Therefore the results of the feedback and training variations were determined on the basis of significant differences in hypothetico-deductive structuring factors and other SSOR measures used from the first teaching session to the second except in the case of the group in Technique IV. For this group differences were determined from the first microsimulation session to the microteaching session. Mean performances for each group on measures of the factors associated with hypothetico-deductive structuring are presented in Table 1.

INSERT TABLE 1 ABOUT HERE

Table 2 presents a summary of the analyses of significant differences between the two criterion sessions provided by t-tests for related samples. Only factors which were used significantly more or significantly less during the second session are presented.

INSERT TABLE 2 ABOUT HERE

FACTOR DIFFERENCES

The conditional move (COND) which is basic to the structuring move, was not used significantly more on the second session for groups not receiving reinforcement. It was used significantly more by the reinforced groups C, D, E, F and H. (Had a preliminary session been conducted prior to training for group C, the increase would probably have been found for this group as well.)

The 7-9 factor was not used consistently more or less for groups exhibiting a significant increase in the use of conditional moves. It was used significantly less by group E but significantly more by groups D and H. The 9-7 factor which is a counterpart to the 7-9 factor, was used significantly less by group E. This was the case for groups F and G as well. Significant correlations with the use of the conditional move for these two factors were found. For the 7-9 factor they ranged from r = .33 to .77. Coefficients for

the 9-7 factor ranged from r = .33 to .60 for untrained groups (A through F) and -.37 to -.54 for the trained groups (G and H).

The three factors 9-16, 16-SR and 9-SR are interrelated. 9-16 refers to a teacher question followed by silence (at least 3 seconds). The 16-SR is silence broken by student response. And the 9-SR indicates student response immediately following a teacher question. Certainly if there is a significant number of 9-SR's then there will be fewer 9-16's and 16-SR's. This seems to be borne out by the significant differences reported for groups B, D, E and F.

Looking at the 9-SR factor alone, it was used significantly more in groups B, D, E, F, G and H. This may indicate the degree of difficulty for the question asked as well as the quality of its delivery. A non-statistical result is that students seem to feel compelled to answer questions delivered through the use of the structuring move. Correlations between the 9-SR factor and the teacher's utilization of conditionals, for example, tend to bear this out with r ranging from .33 to .81. This may explain the increase in 9-SR for groups D, E, F and H. More will be said with regard to this factor in a later section.

The factor associated with the hypothetico portion of the hypothetico-deductive structuring move is 7-7 (teacher statements followed by teacher statements). It is interesting to note that group H which received more training and practice than any other group (and the highest gain in use of conditionals) was the only group with significantly more 7-7 behavior in the criterion session. The correlation between the use of conditional moves and this factor for group H is $\underline{r} = .85$.

CONCOMMITANT BEHAVIORS

The Social Science Observation Record (SSOR) yields measures for seventeen categorical verbal behaviors which constitute four realms and provide the basis for defining twelve sub-matrices (see appendix). The question regarding changes in the total verbal environment as a result of teacher acquisition and utilization of hypothetico-deductive structuring necessitates discussion of these SSOR measures.

This question can best be answered for the present investigation in terms of those behaviors which changed significantly from one criterion session to a second criterion session concommitantly with an increase in the factors associated with the structuring move. The use of conditional moves will remain central to this presentation.

The only realm that consistently increased for groups C through H was Realm I (both frequency and percent). The categorical behaviors which seem to be accounting for this difference are student statements of fact (category 2) and student statements of clarification (category 5). Correlations with COND were .41 and higher for Realm I, .42 and higher for category 2, and .62 and higher for category 5.

Although the realm utilization taken as a whole did not differ significantly for the other three realms, categorical behaviors from them did come into play. The teacher's utilization of infirming and confirming behaviors (categories 6 and 10, respectively) consistently increased as did the frequency and percent of student statements of consequence (category 12) and student emotive behaviors (category 15). It is interesting to note that not all four of these behaviors are correlated with the frequency of teacher conditionals. Significant correlations existed between COND and categories 10 and 15 ($r \geq .79$ and $r \geq .59$, respectively). Significant correlations did not exist for categories 6 and 12.

Extended student talk (at least two continuous codings of student verbal behavior) consistently increased for groups having an increase in the conditional move. In terms of the SSOR measures this is expressed by increased production in submatrices A, C, G and I. Here the combined ACGI frequency

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and percent measures as well as submatrices A, C and G increased consistently and significantly for the groups under discussion. Once again, measures of these variables were not significantly correlated with teacher utilization of the conditional move.

Related to extended student talk are measures of teacher-student and student-teacher interactions. Very simply, if behaviors of this type significantly increase then one objective of the teaching strategies was to include more student response and less teacher lecture. In terms of the SSOR measures, submatrices B and H include teacher behaviors immediately following student statements. Submatrices D and F capture student statements following teacher behaviors, usually teacher questions. The factor ?-SR was reported above as being significantly higher for the majority of the groups. This would constitute behaviors within submatrices D and F. Significant increases are to be expected, therefore, for these submatrices, as was the case. These behaviors combined were directly and significantly related to the teacher's use of conditionals ($\underline{r} \geq .64$ for DF frequency; $\underline{r} \geq .63$ for DF percent).

An increase in B and H also occurred. The increase in categories 6 and 10 mentioned above could be accounting for this increase as the behaviors of infirming and confirming

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generally follow student responses. Recalling that there were no significant correlations between these categorical behaviors and teacher use of conditionals, the finding of low or lack of correlations for the frequency and percentage of submatrices B and H and COND would be expected. But correlations for BH and COND were as high as $r = .77$ for group E. The group not viewing the model (group D) exhibited no correlations between BH and COND.

With this finding and others already mentioned indicating differences between groups D and E, it was decided that in this one instance intragroup comparisons would be made. To this end, analyses of covariance for the hypothetico-deductive structuring factors were performed. Using the first measure as the covariate of the second measure for each factor, two were found to indicate significant differences between the two groups. The two factors were frequency of 9-16 and frequency of 7-9. In both cases, the group not receiving the model (group D) had higher adjusted mean scores than the group that had viewed the model between sessions.

One student behavior coded in addition to the SSOR codings was student use of conditional moves. In the report of the Gregory study (1972), one hypothesis offered was that students might have modeled the teacher's utilization of the language of logic which in turn aided their development of logical

thought. If this were the case then this modeling effect might be apparent in the classroom verbal behaviors. At very least, it would add to the logical language component of the verbal environment and should be measured.

Students involved in this investigation did tend to use the conditional move in sessions where the teacher had already established its utilization. In one instance, after the teacher's first utilization of the conditional, a burst of three student conditionals were coded. The inconsistency of this relationship however, is indicated by the lack of a significant positive relationship for any group.

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CONCLUSIONS

The results of the analyses yield information relevant to the questions with which this phase of the research program was initiated.

1. Can feedback on teaching, mediated by a multidimensional observation instrument assist teachers in the acquisition of these behaviors?

The successive trials indicate that feedback mediated by the SSOR did establish changes in the use of structuring behaviors. It is also apparent that reinforcement is necessary in order to have preservice teachers acquire and utilize these behaviors.

2. Does withholding specific aspects of the feedback process and extending the mediation to include video-tape models of the desired behaviors affect skill acquisition?

In answering this question it is again important to point out the problems associated with cross-group comparisons described earlier. Since it was impossible to have controls in all groups for some of the variables which would account for any differences between groups, the answer to this question has to be considered tenuous. The objective for the series of investigations, however, has been served. A training program has been established, the development of which was

guided by the investigations presented here.

3. What changes in verbal strategies used by teachers can be attributed to both the feedback variation and the acquisition of the verbal structuring skill?

This question deals with the actual change in utilization of the factors associated with the hypothetico-deductive structuring move. The use of the conditional move is central to all of these behaviors.

The changes in frequency of utilization of these factors has been presented in the preceding section. One unexpected result was the occurrence of positive correlations between the 9-7 factor and the use of conditional moves for the untrained groups. Although these subjects were reinforced on the use of conditional moves as an element of the 7-9 factor, they used it more in the 9-7 configuration. Since the trained groups had negative correlations between these two factors, it appears that when teachers initially attempt to incorporate this strategy into their verbal repertoire they experience some difficulty. That is, attempts to decrease the occurrence of 9-7's and increase the use of conditional moves during the same sesson may be contraproductive. Students lacking pretraining consistently added the conditional after the question instead of prior to the question as presented in the theoretical model.

In view of the fluctuations from positive to negative correlations for the 2-7 factor and use of conditional moves indications are that sufficient practice and reinforcement is not provided by one feedback session.

4. What changes in the total verbal environment, with particular concern for the verbal production of students, can be attributed to the modification of the teacher's verbal behavior?

Results of the investigations have led to the identification of two functions of the conditional move which together establish hypothetico-deductive structuring. One function is structuring the context within which questions, responses and discussion occur. A second function is to link teacher questions to the structure thus provided. Thus the hypothetico-deductive structuring move serves to make teacher questions clearer and student understanding more complete.

In terms of the variables measured by the SSOR greater student production and more 2-SR should occur concommitantly with an increase in the utilization of the conditional move. This was the case in view of the significant increases in several variables associated with student behaviors and consistent positive correlations between 2-SR and the use of conditional moves.

DISCUSSION

This report began with a brief description of the three main types of work being conducted within the realm of classroom verbal behavior analysis. The phase of research reported here encompassed all three types. It led to a deeper understanding of one micro-criterion of teaching effectiveness by providing descriptions, correlations and analyses of its function, impact, and acquisition.

Of major importance was the discovery of the hypothetico-deductive structuring move. Its description was enhanced significantly by the measures provided by the Social Science Observation Record. This is not intended to suggest that micro-criteria should no longer be investigated, but that once found, their function may be best studied through the application of multi-dimensional observation systems.

Another interesting feature of the conditional move which was found is that it is content free. Given a random population of teachers of any body of subject matter, investigators should be able to dichotomize that population into groups of teachers who use the move naturally with high frequency and teachers who use the move infrequently or not at all in their lesson presentations. The indication that utilization of conditional moves, and thus hypothetico-

deductive structuring, is an inherent quality of the teacher as an individual may be the very quality which enabled the investigators to manipulate its utilization through modification techniques.

For future efforts, the data suggest several procedural elements to these investigators. The acquisition and utilization of hypothetico-deductive structuring is enhanced by feedback and reinforcement of its function within the classroom verbal environment. It also appears that more practice and reinforcement than is offered by one feedback session is needed by preservice teachers.

The results also suggest that presentation of a prototype video-tape recorded model aids preservice teachers in acquiring desired behaviors. Model viewing is likely to have a greater impact as an element in initial training than it is likely to have as an accompanying element of feedback and reinforcement.

Future investigations of a similar program development nature may be better achieved through the involvement of larger sample sizes. But for similar situations in which the availability of subjects is limited, the research strategy used and reported here provides an alternative. Consideration of the consistency with which change occurs for several smaller samples adds to strength lost due to sample size.

The work completed thus far will enable the investigators to design empirical studies of two types: (1) studies designed to test the relative efficacy of alternative training procedures; and (2) studies designed to test the influence of manipulating teacher utilization of hypothetico-deductive structuring moves on student outcome measures.

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TABLE 1: Group Means for Hypothetico-Deductive Structuring Factors

*Group/Session		FACTORS						
		COND	7-9	9-7	9-SR	9-16	16-SR	7-7
A	I	17	18	5.5	27	2.5	1.0	74
	II	16	24	11.0	29	4.5	3.0	67
B	I	9	17	6.5	33	8.8	5.0	45
	II	6	18	5.8	39	5.0	3.3	34
C	I	4	14	4.3	22	2.5	2.3	53
	II	7	17	3.0	23	3.3	1.5	53
D	I	12	17	6.8	17	6.1	3.5	51
	II	18	20	5.3	28	6.0	2.8	86
E	I	16	25	13.0	18	4.3	2.0	96
	II	21	17	6.0	25	1.8	2.7	101
F	I	14	21	9.9	18	5.3	2.8	73
	II	19	19	5.7	26	3.9	2.8	94
G	I	9	11	4.4	9	2.2	2.1	63
	II	8	11	2.5	15	2.9	2.0	55
H	I	12	12	4.3	9	2.9	2.7	60
	II	20	16	2.0	12	10.8	9.9	131

*Group definitions can be found in Table 2.

TABLE 2: Summary of T-tests for Session Differences on Factors

Group	More:	Less:
A : SSOR data only (N=2)	9-7 **	--
B : Matrix only (N=4)	9-SR **	7-7 ** 16-SR **
C : 7-9 Reinforcement (N=4)	COND *	--
D : H.D. Structuring Reinforcement No Model (N=6)	COND * 7-9 ** 9-SR **	9-16 ** 16-SR *
E : H.D. Structuring Reinforcement plus Model Viewing (N=6)	COND * 9-SR **	7-9 ** 9-7 * 9-16 **
F : H.D. Structuring Reinforcement (D & E combined) (N=12)	COND ** 9-SR **	9-7 ** 9-16 **
G : Pretraining on H.D. Structuring-Microsimulation (N=12)	9-SR **	9-7 *
H: Reinforcement & Training on H.D. Structuring-Microteaching (N=10)	COND ** 7-9 ** 9-16 ** 16-SR ** 7-7 **	9-7 **

* $p < .05$
** $p < .01$

TEACHER: AN OVERVIEW OF FUNCTIONS*

REALM	CATEGORY OF STATEMENT	FUNCTION**
I. Subject-Centered	1. Topical	identifying the focus
	2. Empirical	stating facts
	3. Interpretive	assigning meaning
	4. Defining	avoiding semantical confusion
	5. Clarifying	elaborating ideas
II. Teacher-Centered	6. Infirming	expressing disagreement
	7. Commentary	consolidating and structuring
	8. Dissonant	requesting clarification
	9. Interrogative	eliciting responses
	10. Confirming	accepting
III. Man-Centered	11. Preferential	assigning value ratings
	12. Consequential	anticipating effects
	13. Criterial	identifying the basis
	14. Imperative	considering decisions
	15. Emotive	expressing feelings
IV. Non-Verbal	16. Silence	wait time
	17. Confusion	adjustment time

*J. Doyle Casteel and Robert J. Stahl (c. 1973).
**The functions as given are meant to be illustrative but not inclusive.

SOCIAL SCIENCE OBSERVATION RECORD (SSOR) MATRIX

College of Education, University of Florida